CLAIMS

1. A man-machine interface comprising:

at least one planar substrate having formed thereon a magnetic field generator, the magnetic field generator comprising conductive tracks formed on at least two planes defined by the at least one planar substrate;

a mounting carrying an intermediate coupling element, the mounting allowing movement of the intermediate coupling element along a measurement direction transverse to the planar substrate in response to a force applied by a user; and

a detector operable to detect the position of the intermediate coupling element in a magnetic field generated by the magnetic field generator.

2. A man-machine interface according to claim 1, wherein the measurement direction is perpendicular to the or each planar substrate.

3. A man-machine interface according to claim 1, wherein the or each planar substrate has an aperture formed therethrough which is aligned with the measurement direction.

4. A man-machine interface according to claim 1, wherein the mounting defines an outer side and an inner side, wherein the at least one printed circuit

board and the detector are provide on the inner side, and the mounting provides a seal between the inner side and the outer side.

5. A man-machine interface according to claim 1, wherein the intermediate coupling element comprises a magnetically permeable body.

6. A man-machine interface according to claim 5, wherein the magnetically permeable body is a ferrite element.

7. A man-machine interface according to claim 1, wherein the intermediate coupling element comprises a resonant circuit.

8. A man-machine interface according to claim 1, wherein the at least one planar substrate comprises a printed circuit board.

9. A man-machine interface according to claim 1, wherein the at least one planar substrate comprises plural layers of a multi-layer printed circuit board.

10. A man-machine interface according to claim 1, wherein the magnetic field generator comprises a transmit aerial and the detector comprises a receive aerial, and wherein movement of the intermediate coupling element along the measurement direction

varies the electromagnetic coupling between the transmit aerial and the receive aerial.

11. A man-machine interface according to claim 10, wherein the transmit aerial comprises a first excitation winding and a second excitation winding,

wherein in response to current flowing through the first excitation winding, a magnetic field is generated having a component in the measurement direction which varies with position along the measurement direction in accordance with a first function, and

wherein in response to current flowing through the second excitation winding, a magnetic field is generated having a component in the measurement direction which varies with position along the measurement direction in accordance with a second function which is different to the first function.

12. A man-machine interface according to claim 11, wherein the first function is a sine function, the second function is a cosine function, and the man-machine interface further comprises:

a signal generator operable to apply a pair of oscillating signal components which are in phase quadrature with each other to the first excitation winding and the second excitation winding respectively; and

a signal processor operable to measure the phase

of a signal component induced in the receive aerial to determine the position of the intermediate coupling element.

13. A man-machine interface according to claim 10, wherein the transmit aerial and the receive aerial are formed by conductive tracks formed on a first planar surface and a second planar surface on either side of a single-layer planar substrate and by through-plated via-holes through the single planar substrate.

14. A man-machine interface according to claim 13, wherein the planar substrate is a printed circuit board.

15. A man-machine interface according to claim 13, wherein the transmit aerial comprises a first excitation winding and a second excitation winding,

wherein the first excitation winding comprises at least one coil which is arranged about a first axis, which is in the plane of the planar substrate, such that in response to current flowing through the first excitation winding, a magnetic field is generated having a component along the measurement direction which varies in accordance with a first function, and

wherein the second excitation winding comprises a at least one coil which is arranged about a second axis, which is perpendicular to the plane of the planar substrate, such that in response to current

flowing through the second excitation winding, a magnetic field is generated having a component along the measurement direction which varies in accordance with a second function which is different from the first function.

16. A man-machine interface according to claim 15, wherein over a measurement range the first function is substantially a sine function and the second function is substantially a cosine function.

17. A man-machine interface according to claim 13, wherein the first excitation winding further comprises a first coil and a second coil about the first axis, the second coil being on the opposite side of the aperture to the first sine coil.

18. A man-machine interface according to claim 13, wherein the second excitation winding comprises a first coil and a second coil, the second coil being on the opposite side of the aperture to the first coil.

19. A push button comprising:

a planar substrate defining an aperture;

an actuator operable to move a magnetically permeable body through the aperture along a measurement direction; and

a sensor for sensing the position of the magnetically permeable body relative to the planar

substrate,

wherein the sensor comprises at least two planar windings, spaced apart along the measurement direction, provided on said at least one planar substrate, each planar winding being formed in a spiral about the aperture so that the inductance of each winding varies in dependence upon the position of the magnetically permeable element in the measurement direction.

20. A push button according to claim 19, wherein the planar substrate comprises a printed circuit board.

21. A keyboard comprising a plurality of push buttons as claimed in claim 19.

22. A keyboard according to claim 21, wherein the plurality of push buttons have a common planar substrate.

23. A keyboard according to claim 21, wherein the magnetically permeable body of the actuator of each push button is connected to a common membrane.

24. A position sensor comprising:

a plurality of planar substrates with each planar substrate having a respective aperture, wherein the plurality of planar substrates are arranged in parallel with the respective plurality of apertures

aligned along a measurement direction;

a sensor element operable to move relative to the plurality of planar substrates along the measurement direction; and

a first aerial and a second aerial, wherein the electromagnetic coupling between the first aerial and the second aerial varies in dependence upon the position of the sensor element relative to the plurality of planar substrates along the measurement direction,

wherein at least one of the first and second aerials comprises a conductor having conductive track portions provided on at least two planar surfaces of the plurality of planar substrates.

25. A position sensor according to claim 24, wherein the plurality of planar substrates form respective layers of a laminar structure.

26. A position sensor according to claim 25, wherein the laminar structure is a multi-layer printed circuit board.

27. A position sensor according to claim 24, wherein said conductive track portions are connected via at least one hole through at least one of the plurality of planar substrates.

28. A position sensor according to claim 24, wherein

the conductor is operable to generate a magnetic field having a magnetic field component parallel with the measurement direction which varies along the measurement direction.

29. A position sensor according to claim 28, wherein said magnetic field component varies sinusoidally along the measurement direction.

30. A position sensor according to claim 24, wherein said at least one of the first and second aerials further comprises a second conductor having conductive track portions on at least two of the planar substrates.

31. A position sensor according to claim 30, wherein the second conductor is operable to generate a magnetic field having a magnetic field component parallel with the measurement direction which varies along the measurement direction.

32. A position sensor according to claim 31, wherein said magnetic field component of the second conductor varies sinusoidally along the measurement direction one quarter of a cycle out of phase with said magnetic field component of the first-mentioned conductor.

33. A position sensor comprising:

at least one planar substrate having formed

thereon a magnetic field generator, the magnetic field generator comprising conductive tracks formed on at least two planes defined by the at least one planar substrate;

an intermediate coupling element operable to move relative to the at least one planar substrate along a measurement direction transverse to the planar substrate; and

a detector operable to detect the position of the intermediate coupling element in a magnetic field generated by the magnetic field generator.

34. A position sensor according to claim 33, wherein the measurement direction is perpendicular to the or each planar substrate.

35. A position sensor according to claim 33, wherein the or each planar substrate has an aperture formed therethrough which is aligned with the measurement direction.

36. A position sensor according to claim 33, wherein the planar substrate is a printed circuit board.

37. A position sensor according to claim 33, wherein the magnetic field generator comprises a transmit aerial and the detector comprises a receive aerial, and wherein movement of the intermediate coupling element along the measurement direction varies the

electromagnetic coupling between the transmit aerial and the receive aerial.

38. A position sensor according to claim 37, wherein the transmit aerial comprises a first excitation winding and a second excitation winding,

wherein the first excitation winding comprises at least one coil which is arranged about a first axis, which is in the plane of the planar substrate, such that in response to current flowing through the first excitation winding, a magnetic field is generated having a component along the measurement direction which varies in accordance with a first function, and

wherein the second excitation winding comprises a at least one coil which is arranged about a second axis, which is perpendicular to the plane of the planar substrate, such that in response to current flowing through the second excitation winding, a magnetic field is generated having a component along the measurement direction which varies in accordance with a second function which is different from the first function.

39. A position sensor according to claim 38, wherein over a measurement range the first function is substantially a sine function and the second function is substantially a cosine function.

40. A position sensor according to claim 38, wherein

the first excitation winding further comprises a first coil and a second coil about the first axis, the second coil being on the opposite side of the measurement direction to the first sine coil.

41. A position sensor according to claim 38, wherein the second excitation winding comprises a first coil and a second coil, the second coil being on the opposite side of the measurement direction to the first coil.

42. A rotary encoder comprising:

a shaft mounted in a mounting for rotational movement about an axis;

a sensor element coupled to the shaft so that in response to rotational movement of the shaft, the sensor element correspondingly moves along the axis of rotation;

at least one planar substrate having formed thereon a magnetic field generator, the magnetic field generator comprising conductive tracks formed on at least two planes defined by the at least one planar substrate, wherein the axis of rotation crosses the at least one planar substrate; and

a detector operable to detect the position of the sensor element in a magnetic field generated by the magnetic field generator.

43. A rotary switch comprising:

a switch head fixed to a shaft, the shaft being mounted in a mounting which allows a range of rotary movement of the shaft about an axis;

a follower coupled to the shaft and operable to move over a range of linear movement in concert with rotation of the shaft about said axis, wherein each position within the range of rotary movement of the shaft corresponds to a single position within the range of linear movement of the follower;

at least one planar substrate having formed thereon a magnetic field generator, the magnetic field generator comprising conductive tracks formed on at least two planes defined by the at least one planar substrate; and

a detector operable to detect the position of the follower in a magnetic field generated by the magnetic field generator.